Efficient Implementation of Agri-insurance Schemes by Piggybacking eSagu* System†

G. Syamasundar Reddy and P. Krishna Reddy
Media Lab Asia Project
International Institute of Information Technology,
Gachibowli, Hyderabad, India
E-mail: shyamiiit@gmail.com, pkreddy@iiit.ac.in

Abstract

Timely agro-advisory service and efficient risk mitigation mechanisms can provide stable income to the farmers. To provide timely agro-advisory service, e-Sagu system has been developed by IIIT-Hyderabad and Media Lab Asia. It is an IT-based personalized agro-advisory system which is being developed to provide high-quality personalized (farm-specific) agricultural expert advice to each and every farm in a timely manner at the farmer's door-step without farmer asking a question. The results show that significant benefits have flown to the farmers in terms of reduced inputs and enhanced yield. Regarding risk mitigation, the agri-insurance schemes around the world whether an advanced or a developing nation like India are suffering due to catastrophic losses, covariate risks, asymmetric information and lack of quality data. These problems may pose a serious threat to the survival of the implementing agencies unless the there is an effective monitoring system in place, with enough man power and robust infrastructure. In this paper we explain how agri-insurance schemes can be effectively implemented on top of eSagu system. The agri-insurance scheme can be very cost-effective as it can use resources and processes of eSagu system. Also, as eSagu provides quality and reliable data at farm level, the problem of asymmetric information can be effectively hedged. Most important, eSagu also improves the performance of formal risk mitigation mechanisms through farm-specific agro-advisory and monitoring system.

Key words: eSagu, agri-insurance, ICTs for rural development, ICTs for agriculture, ICTs for insurance, Personalized agro-advisory.

1. Introduction

Agriculture in developing nations is characterized by small holdings, ill-structured institutional credit, unpredictable market fluctuations and feeble extension systems in addition to natural disasters like cyclones, floods, drought, hailstorms etc. besides frequent pest out-breaks. However, majority of developing economies in the world are invariably depended on agricultural production where India is not an exception.

Timely agro-advisory service and efficient risk mitigation mechanisms can provide stable income to the farmers. To provide timely agro-advisory, efforts are going on to develop a IT-based cost-effective personalized agro-advisory system, called eSagu, to reduce the lab to land gap and improve the profitability of the farmer (Krishna Reddy P, et al, 2005, Krishna Reddy, P, et al 2006, Ratnam BV et al 2006). The e-Sagu system has been developed by IIIT-Hyderabad and Media Lab Asia. It is an IT-based personalized agricultural advice delivery system which is being developed to provide

* eSagu is a trademark of IIIT, Hyderabad and Media Lab Asia. It is an IT-based Personalized Agro-advisory System.

† Presented at Third National Workshop on "ICT and Agriculture: From Potential to Prosperity in a Global Perspective", IAITA and DA-IICT, Ahmedabad, India, 15-16, June 2006.

high-quality personalized (farm-specific) agricultural expert advice to each and every farm in a timely manner at the farmer's door-step without farmer asking a question. The advice is provided once in a week from sowing to harvesting. During 2005-06, eSagu has been implemented in 30 villages in Andhra Pradesh for six crops. The results show that significant benefits have flown to the farmers in terms of reduced inputs and enhanced yield.

In addition to agro-advisory service, crop insurance is recognized as the basic instrument for sustainable agriculture development. However, the agri-insurance schemes around the world whether an advanced or a developing nation are suffering due to catastrophic losses, covariate risks, asymmetric information and lack of quality data. These problems may pose a serious threat to the survival of the implementing agencies unless the there is an effective monitoring system in place, with enough man power and robust infrastructure. Like many other nations, the financial experience of the Indian government also has been disastrous as the indemnities paid were always exceeded more than 300%, invariably making it a huge burden on the government's exchequer.

In this paper we explain how agri-insurance schemes can be effectively implemented by piggybacking eSagu system which is being developed to provide agro-advisory service. The agri-insurance scheme can be very cost-effective as it is piggybacking eSagu system; the information collected by the eSagu system can effectively hedge the problem of asymmetric information besides providing quality and reliable data at farm-level. Most important, eSagu also improves the performance of other formal risk mitigation mechanisms through farm-specific monitoring system.

The rest of the paper is organized as follows. In the next section, we explain the problems associated with implementing the crop insurance scheme. In section 3, we review the implementation of crop insurance schemes in USA and Japan. In section 4, we discuss the evolution of crop insurance scheme in India, current schemes and experience. In section 5, we briefly explain eSagu and its benefits. In section 6, we explain how crop insurance scheme can be effectively implemented by piggybacking eSagu system. The last section contains summary and conclusions.

2. The problems of crop insurance implementation

The prosperity of any nation would obviously depend upon its secured food bases and the sustained producing power of its farmers even after catastrophic loses. But, prevalence of risk in agriculture has become a rule rather than exception. In this regard farmers, rural institutions and money lenders have, over generations, developed several informal risk mitigation mechanisms such as crop diversification, intercropping, diversification of income source, buffer stock accumulation of crops or liquid assets, crop and labour sharing etc (World Bank, 2001 and Townsend, 2005). Some of these instruments (eg. crop diversification and intercropping are less profitable than crop specialization) can be very costly in terms of the income opportunities that farmers forego as they can discourage investments and technological changes that can enhance long term productivity growth. At the same time, formal risk mitigation mechanisms such as agricultural extension systems, pest prediction & management systems, formal credit lending systems, future contracts and **crop insurance** were evolved with support from both public and private sectors. Among the formal mechanisms, crop insurance is recognized to be the basic instrument for maintaining stability in farm income through promoting technology, encouraging investment and increasing credit flow in the agricultural sector. It contributes to self-reliance and self-respect among the farmers, since

in cases of crop loss they can claim compensation as a matter of right (Chandrakanth, 1980). Thus, crop insurance cushions the shock of crop loss by assuring farmers protection against natural hazards that are beyond their control. However, the financial experiences of majority of the governments around the world were more or less similar with respect to crop insurance where the ratio of indemnities paid to premiums collected was more than three baring Japan as an exception (indemnities to premium ratio less than one).

The basic principle underlying crop insurance is that the loss incurred by a few farmers is shared by many in an area. Also, losses incurred in bad years are compensated from resources accumulated in good years (Dandekar, 1976). We now discuss the basic problems associated with crop insurance.

i. Catastrophic losses and covariate risks: The crop damage due to natural hazards like cyclones, floods, hailstorms, drought etc. will generally occur over a vast geographic area. The incidence of damage will rarely be independent both spatially and temporally. In such cases the insurer has to pay large sums towards claims and this problem compounds when the event of damage is spatially correlated between other geographic areas also. But in case of other insurance programmes, the incidence of damage will usually be sporadic and independent to one another thus making them financially viable, but profitable as well (Freeman, 2002).

ii. Asymmetric information: Asymmetric information typically causes two problems; adverse selection and moral hazard. In the case of adverse selection, farmers have better knowledge than the insurer about the probability and distribution of losses. Thus, the farmers have the privileged situation of being able to discern whether or not the insurance premium accurately reflects the risk they face. Consequently, only farmers that bear risks will purchase the coverage, generating an imbalance between indemnities paid and premiums collected. Moral hazard is another problem that lies within the incentive structure of the relationship between the insurer and the insured. After entering the contract, the farmer's incentives to take proper care of the crop diminish, while the insurer has limited effective means to monitor the eventual hazardous behavior of the farmer. This might also results in greater losses for the insurer (World Bank, 2005).

iii. Lack of quality and reliable data: Collection and accumulation of quality and reliable data is the most important asset for crop insurance programme. There may be a lot of disparity between the data collected at county level and country level. Small sample size may create large measurement error, especially when the underlying probability distribution is heavily skewed. Kunreuther et al. (1993) demonstrated via experimental economics that when risk estimates are ambiguous, loads on insurance premiums can be 1.8 times higher. The accuracy in field level data will be of immense use not only for designing actuarially sound premiums but also for evaluating the nature and magnitude of risks involved at various levels of coverage.

iv. Administrative costs: Constant and continuous monitoring is vital for the successful implementation of any programme. Operation of crop insurance scheme requires a lot of trained man power and robust infrastructure for acquiring data to establish accurate premiums, administering the contracts; rapid assessment of losses in the event of a catastrophe, conducting claims adjustment and to address the asymmetric information problems. Since administrative costs constitute part of the premium, more the administrative costs more will be the premium charged. This component will be more critical in case of developing nations because of small farm holdings in great numbers since smaller the policy (farm), greater the administrative costs.

3. Crop Insurance Schemes in USA and Japan

In this section we briefly explain the crop insurance schemes of USA and Japan.

3.1 Federal Crop Insurance Programme (FCIP) in the USA:

Multi-peril yield and revenue insurance products are offered by the public and private sector companies to all the eligible farmers in the USA irrespective of their past loss history with a dual goal of addressing social welfare and economic efficiency. The federal government provides farmers with a base catastrophic yield insurance policy, free of any premium costs. Instead farmers have to pay a nominal amount towards administrative fee per policy. An additional insurance coverage beyond the catastrophic level called 'buy up' coverage is available at federally subsidized prices that may be either yield or revenue insurance. Farm-level revenue insurance offers are based on the product of the actual production history (APH) yield and a price index that reflects national price movements for the particular commodity. The actual production histories forms the backbone for insurance contracts that covers the production risks while the commodity futures and options spearheads the contracts that cover the price risk. The standard reinsurance agreement (SRA) and federal subsidies serve as a back end support to sustain the crop insurance programme. The brief note of these important parameters is given below-

i. Actual Production History (APH): It is a farmer's yield history for the unit to be insured that determine the farmer's premium rate as well as his yield guarantee. The APH is a simple average of 4-10 years of historical yields for the unit that is insured. If farmers do not have 4 years of yield records, a yield namely transition yield (t-yield) is assigned to the farmer. The t-yield is generally the county average for the crop (based on the past 10 years of data provided by the National Agricultural Statistics Service). If the growers have no records but have grown the crop in the past two years, they are assigned a yield equal to 65 per cent of the t-yield. With one year of records, growers are assigned a yield equal to 80 per cent of the t-yield and three years of records result in a assignment of the t-yield for the fourth year. In these cases, the one to three actual yields are averaged with the t-yields. Changes in the APH are "cupped" and "capped" from one year to the next. The cup or downward limit on the APH is 10% of the previous APH. This means that a grower's APH can not drop by more than 10% from one year to the next year. In addition, if farmers have four or more yield records, their APH is not allowed to fall below 80% of the t-yield. The cap or upward limit on the APH is 20% of the previous APH. This means that a grower's APH can not increase by more than 20% from one year to the next (Stephen Frerichs, 1999).

ii. Commodity Futures and Options: Price variability can be managed by entering into pre-harvest agreements that set a specific price for future delivery. These arrangements are known as forward contracts and allow producers to lock in a certain price, thus reducing risk. In specific markets, and for specific products, these kinds of arrangements have evolved into futures contracts traded on regulated exchanges on the basis of specific trading rules and for specific standardized products. Further, price options allow the producers to sell futures contracts taking advantage of positive price changes. Futures and options can not only be effective price risk management tools but also important price discovery devices and market trend indicators.

iii. Standard Reinsurance Agreement (SRA): In any insurance, the sum insured (liability) will be very high when compared to the premiums collected. Given the conditions of catastrophic losses and covariate risks in crop insurance, it is impossible for any insurance agency to bear this magnitude of risk. However, reinsurance can help to

transfer the liability to some other agency at the international level if claims exceed far beyond the premiums collected in cases of extensive natural disasters. Even though, there are several reinsurance companies at international level, it is difficult to get the reinsurance for crop insurance programme. Hence, the federal government provides the reinsurance mechanism namely, the Standard Reinsurance Agreement (SRA) that will also allow the insurance companies to determine which policies they will retain and which they will cede to the government (USDA, 2005).

iv. Federal Subsidies: The crop insurance programme in the United States of America is characterized by large volumes of subsidies by the federal government at various levels. The premium subsidies range from 100 per cent of total premium for catastrophic (CAT) policies to 38 per cent for buy-up policies at the highest coverage levels. The SRA has an embedded federal subsidy with an expected value of 14 per cent of total premiums. The programme, by law, is allowed to be called actuarially sound at a loss ratio of 1.075 which implies an additional federal subsidy of 7.5 per cent of total premiums. Also, the federal government reimburses administrative and operating expenses for the private insurance companies that sell and service the policies that amount to 22 per cent (approx.) of total premiums. On an average, the federal government pays approximately 70 per cent of total costs for the Federal Crop Insurance Programme (World Bank, 2005).

3.2 Crop Insurance in Japan:

Japan is the only country that has been successful in implementing crop insurance scheme on a nation wide basis and is reckoned as the world's largest in terms of the number of farmers insured. The striking difference with Japan when compared to other developed nations is its small-scale cultivation where the basic unit of insurance is essentially the owner-operated family farm. Moreover, the Japanese agricultural insurance scheme has no direct linkage with formal credit institution unlike in western developed countries like USA and the Asian developing countries like India (Manoj Kumar, 2003). Some of the essential features that contributed to the success of Japanese crop insurance scheme are listed below:

1. Implementation of crop insurance programme is compulsory as stipulated by laws and ordinances.
2. Farmer's participation is compulsory. A large amount of government subsidy is provided not only for administrative expenses but for premium payment as well.
3. The government itself conducts the reinsurance business in order to carry out the insurance programme smoothly.
4. The structurally well established National Agricultural Insurance Association (NAIA), a corporate judicial body that make lobbying, conduct research, carry out publicity and organize training courses on agricultural insurance programme.
5. The operational dynamism of "Farmers Associations" that shoulder the responsibility of the entire crop insurance operations at the gross roots level.

Farmers Association: The farmers association is an organization established in each locality (village, town or city) with all the farmers in that area whose planted acreage exceeds a prescribed minimum. This association is basically responsible for the entire operation of crop insurance scheme at the gross roots level. It undertake the basic activities such as making mutual relief contracts, collecting premiums from the insured, making loss assessments, paying indemnities and proving the farmers with loss-prevention guidance (extension). The association also has an autonomous function of electing the leaders of the federation, communicating their needs to the higher levels, retain some portion of the premium collected in the form of deposits and carry out loss-prevention activities of their own. The Japanese crop insurance programme derived the following benefits out of these farmers association-

- The government of Japan has developed necessary instruments to fix the inherent risks associated with the crop insurance programme such as moral hazard and adverse selection.
- Immediate appraisal and rapid loss assessment procedures are absolutely essential as the farmers may wish to harvest the undamaged part of the affected crop in due time when ever there was a catastrophe. It requires a large number of trained personnel capable of responding immediately to appraise the losses. This function is being effectively carried out by the association.
- Another important activity, the association under takes is the loss prevention guidance to the farmers. It also brings down the unit cost of the production by purchasing the inputs in bulk and distribute to the farmers. It also facilitates for marketing of the produce besides bargaining for better price.

Hazell reported the financial performance of crop insurance programme in seven countries as presented in the table-

Financial performance of crop insurance programme in seven countries:

Country	Period	I/P	A/P	(A+I)/P
Brazil	1975-81	4.29	0.28	4.57
Costa Rica	1970-89	2.26	0.54	2.80
India	1985-89	5.11	-	-
Japan	1985-89	0.99	3.57	4.56
Mexico	1980-89	3.18	0.47	3.65
Philippines	1981-89	3.94	1.80	5.74
USA	1980-89	1.87	0.55	2.42

(Source: Hazell, 1992)

Hazell quantifies the conditions for sustainable insurance as follows:

$$(A+I)/P < 1$$

Where

A = Average administrative costs
I = Average indemnities paid
P = Average premiums paid

As per the table above, the ratio of indemnities paid to premiums collected (I/P) is less than one (0.99) only in case of Japan while the USA (1.87) stands next to Japan in controlling the loss followed by Costa Rica (2.26) and the I/P ratio is comparatively high (5.11) in case of India. However the ratio of administrative costs to premiums collected is very high (3.57) in Japan when compared to the USA (0.55) and Costa Rica (0.54). The high administrative costs of Japanese crop insurance scheme were attributed to its robust organizational structure starting from 'farmers associations' at gross roots level up to 'National Agricultural Insurance Association' at the apex level. The operational dynamism of these associations largely contributed to the success of Japanese crop insurance programme, particularly, the indemnities paid. When it comes to the over all loss ratio, (A+I)/P none of the above nations derived any advantage indicating that crop insurance programme whether for an advanced or a developing country, can not be designed with out sacrificing some of the preceding rigid requirements.

4. Crop insurance scheme in India:

In this section, after describing the evolution of crop insurance scheme, we explain current schemes and experience of Indian crop insurance.

4.1 Evolution:

The question of introduction of a crop insurance scheme was taken up for examination soon after the Indian independence in 1947. The first aspect regarding the modalities of crop insurance considered was whether the same should be on an **'**individual approach' or on **'**homogenous area approach'. The former seeks to indemnify the farmer to the full extent of the losses and the premium to be paid by him is determined with reference to his own past yield and loss experience. The 'individual approach' basis necessitates reliable and accurate data of crop yields of individual farmers for a sufficiently long period, for fixation of premium on actuarially sound basis. The 'homogenous area' approach envisages that in the absence of reliable data of individual farmers and in view of the moral hazards involved in the 'individual approach', a contiguous area comprising villages that are homogenous from the point of view of crop production and whose annual variability of crop production would be similar, would form the basic unit, instead of an individual farmer. A special study commissioned in the year 1947-48 was reported in favour of the 'homogenous area' approach even as various agro-climatically homogenous areas treated as a single unit and the individual farmers in such cases pay the same rate of premium and receive the same benefits, irrespective of their individual fortunes.

The first ever crop insurance scheme in India was implemented based on the **'individual approach'** only. This scheme was started on an experimental basis in the year 1972-73 and continued up to 1978-79 covering 3110 farmers for a premium of Rs. 4.54 lakh against claims of Rs. 37.88 lakh. In the background of above experience, a pilot crop insurance scheme (PCIS) was introduced based on **'area approach'** in the year 1979. This scheme was limited to the loanee farmers on voluntary basis with a premium subsidy of 50 per cent for small/marginal farmers. This pilot scheme was implemented till 1984-85 covering 6.27 lakh farmers for a premium of Rs. 196.95 lakh against claims of Rs. 157.05 lakh. With this experience, the commercial crop insurance scheme (CCIS) was introduced based on **'homogenous area approach'** with effect from 1st April, 1985. Interestingly, this scheme was made compulsory to all the loanee farmers of rural financial institutions while it was voluntary to non-loanee farmers. This scheme had covered 7.62 lakh farmers for a premium of Rs. 403.56 crore against claims of Rs. 2303.45 crore till kharif 1999. While, CCIS was still being implemented, a new scheme, viz. Experimental Crop Insurance Scheme (ECIS) was implemented during Rabi 1997-98 exclusively for small/marginal farmers with 100 per cent subsidy in premium. This scheme covered 4.54 lakh farmers for a premium of Rs. 2.84 crore against claims of 37.80 crore and it was immediately discontinued due to many of its administrative and financial difficulties.

4.2 Current schemes:

There are several agri-insurance schemes in vogue viz. the National Agricultural Insurance Scheme (1999), the Drought Risk Insurance (2002), the Rainfall Insurance (2005) and the Coffee Rainfall Index & Area Yield Insurance (2005). The schemes on pilot run are the Pilot Scheme on Seed Crop Insurance (PSSCI) and the Pilot Project on Farm Income Insurance (PPFIIS). The most prominent among the above schemes is the National Agricultural Insurance Scheme (NAIS) and the principal objectives of this programme are to provide insurance coverage and financial support to the farmers in the event of failure of any of the notified crop as a result of natural calamities, pest out-breaks etc.; to encourage the farmers to adopt progressive farming practices, high value inputs

and higher technology in agriculture and finally to help stabilize farm incomes, particularly in disaster years. The scheme would operate on the basis of 'homogenous area approach' for wide spread natural calamities and on an 'individual approach' for localized calamities such as hailstorm, land slide, inundation etc. All farmers including sharecroppers, tenant farmers growing notified crops in the notified areas are eligible for coverage under this scheme; however, it is absolutely compulsory for loanee farmers who avail Seasonal Agricultural Operations (SAO) loans from financial institutions while it is optional for non-loanee farmers. The Sum Insured (SI) may extend to the value of the Threshold Yield (TY) of the insured crop at the option of the insured farmers. However, a may also insure his crop beyond value of Threshold Yield level upto 150% of Average Yield of notified area on payment of premium at commercial rates. A premium subsidy of 50% is available for small/marginal farmers which will be phased out on a sunset basis in a period of three to five years. The indemnity will be paid on 'Actual Yield' (AY) i.e. if the actual yield per hectare of the insured crop for the defined area (on the basis of requisite number of crop cutting experiments) in the insured season, falls short of the specified 'Threshold Yield', all the insured farmers growing that crop in the defined area are deemed to have suffered shortfall in their yield.

The administrative expenses would be shared equally by the central government and the respective state governments on sunset basis (100% in the 1st year, 80% in the 2nd year, 60% in the 3rd year, 40% in the 4th year, 20% in the 5th year and zero thereafter). A Corpus Fund (CF) is created with contributions from the government of India and State on 50:50 basis which will be managed by the Agricultural Insurance Company of India (implementing agency) to meet the catastrophic losses. A portion of Calamity Relief Fund (CRF) shall be used for used for contribution to the Corpus Fund. Efforts should be made by the AIC of India to obtain appropriate reinsurance cover for the NAIS in the international reinsurance market. During each crop season, the agricultural situation will be closely monitored in the implementing states for which a District Level Monitoring Committee (DLMC) would be set up by the respective state department of agriculture and district administration to provide fortnightly reports of agricultural situation with details of area sown, seasonal weather conditions, pest incidence, stage of crop failure etc. Transition to the actuarial regime would be made in a period of five years.

4.3 The Indian experience:

The current national agricultural insurance scheme (NAIS) which is supposed to become financially viable, charging farmers premiums based on actuarial rates by now, is being struggled by its inherited flaws. The financial experience of the government with the crop insurance including NAIS has been disastrous as the indemnities paid were always exceeding more than 200% in all the schemes except the PCIS, invariably making it a huge burden on the government's exchequer (table 2). Given the group character in area based approach, it would appear that in many cases where the actual loss was serious, little or no compensation was paid. There are also cases, where there was little or no loss, but the compensation as based on block experience. Like any other crop insurance scheme in the world, the crop insurance scheme in India had also seriously suffered due to moral hazard and adverse selection, the inherent problems associated with crop insurance (Jennifer Ifft, 2001).

Table 2: Financial experience of Indian government with different crop insurance schemes

S. No.	Name of the scheme	Period	Farmers covered	Premiums collected (lakhs) (P)	Indemnities paid (lakhs) (I)	I/P ratio
1	Experimental schemes	1972-79	3110	4.54	37.88	8.34
2	PCIS	1979-85	6,27,000	196.95	157.05	0.80
3	CCIS	1985-99	7,62,65,438	403.56	2303.45	5.71
4	ECIS	1997-98	4,54,555	284.00	3780.00	13.31
5	NAIS	1999-2005*	7,37,03,699	218501.15	591571.29	2.71

* indicates, the scheme is currently in vogue.

5. Overview of eSagu

5.1 Introduction

eSagu is a tool for IT-based personalized agricultural extension system. ("Sagu" means cultivation in Telugu language). It aims to improve farm productivity by delivering high quality personalized (farm-specific) agro-expert advice in a timely manner to each farm at the farmer's door-steps without farmer asking a question. The advice is provided on regular basis (typically once a week) from sowing to harvesting which reduces the cost of cultivation and increases the farm productivity as well as quality of agri-commodities. In eSagu, the developments in IT such as (database, Internet, and digital photography) are extended to improve the performance of agricultural agro-advisory services. eSagu offers the next generation, self-sustainable agro-advisory tool that can supplement or complement the existing agro-advisory systems.

5.2 eSagu architecture

In e-Sagu, rather than visiting the crop in person, the agricultural scientist delivers the expert advice by getting the crop status in the form of digital photographs and other information. The description eSagu is as follows (Figure 1): The **farmers** are the end users of the system and can be illiterate. A **coordinator** is an educated and experienced farmer who can be found in the village. **Agricultural Experts** possess a university degree in agriculture and are qualified to provide expert advice. **Agricultural Information System** is a computer based information system that contains all the related information. **Communication system** is a mechanism to transmit information between farms to agricultural experts and vice versa. If enough bandwidth is not available, information can be transmitted through courier service. However, the advice text can be transmitted through dial-up Internet connection.

5.3 Operation of eSagu

The operation of eSagu is as follows- A team of agricultural experts work at the eSagu (main) lab (normally in a city) supported by agricultural information system. One small computer center (few computers and one computer operator) is established for a group of five to six villages. Appropriate numbers of coordinators were selected from the villages. Depending on the crop, each coordinator is assigned a fixed number of farms. The coordinator collects the registration

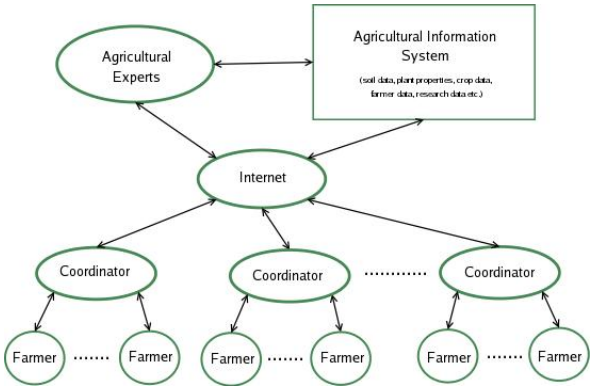

Figure 1: The parts of eSagu System.

details of the farms under him including soil data, water resources, and capital availability and sends the information to the main eSagu system. Every day, the coordinator visits a fixed number of farms and takes four to five photographs for each farm. A CD is prepared with the photographs and other information and transported to the main system by a regular parcel service. The Agri-experts, with diverse background (Entomology, Pathology, Agronomy, Horticulture, Soil Science, etc.) at the eSagu (main) lab analyze the crop situation with respect to soil, weather and other agronomic practices and prepare a farm specific advice. This advice is downloaded at the village eSagu center electronically through a dial-up Internet connection. The coordinator collects the advice and delivers it to the concerned farmer. Each farm gets the advice at the regular intervals starting from pre-sowing operations to post-harvest precautions.

5.4 Summary of implementation

The development of eSagu was strated during Kharif 2004 (http://www.esagu.in). The system has provided the personalized expert advice each farm once in a week (by analyzing the photographs) to 1051 cotton crops in Oorugonda, Gudeppad and Oglapur villages of Atmakur mandal in Warangal district (Andhra Pradesh, India). The eSagu main system was built at IIIT, Hyderabad. The system was very successful. Encouraged by results, during Kharif and Rabi 2006, a scaled-up version of cluster-based eSagu for 5000 farms has been implemented on the following crops: Cotton, Chilli, Rice, Groundnut, Castor, and Redgram by selecting two to three villages for each crop. The results are very encouraging. Efforts are on to build a self-sustainable and replicable eSagu for all crops. The results of the eSagu project are as follows.

- The results show that it is possible for the agriculture expert to deliver expert advice based on the photographs and other information.
- The farmers are pleased with the expert advice as it is helping the farmers to improve input efficiency by encouraging integrated pest management (IPM) methods, judicious use of pesticides and fertilizers by avoiding their indiscriminate usage.
- The benefit to cost ratio was 3. The evaluation study shows that the e-Sagu farmers accumulated benefits worth Rs. 3820/- per acre in monitory terms an addition to the gain in terms of knowledge.
- Each agriculture expert can deliver advices to 150 farms a day. Each coordinator can send crop observation for 30 farms a day.
- The round-trip advice delivery time is 24-36 hours (farm to lab and back to farmer's house).
- In Warangal district , the farmers have paid the registration fees and satisfied with the service.
- An effort is being made to start agri-business center in one of the center by providing multiple services under one roof. The services include expert advice, agri-inputs, banking, warehousing, and marketing.
- The eSagu system is providing significant benefits to capital intensive crops such as cotton and chilies. It is also very effective for rice crop. For other crops, alternative models have to be developed to make the eSagu cost-effective.

5.5 Benefits of eSagu

Powered by the latest developments in ICTs such as database, Internet, and photographic technologies, e-Sagu offers a multitude of comprehensive

advantages and provides opportunity to improve the existing agricultural agro-advisory systems.

- It provides a high quality personalized expert advice.
- It is a query-less system and provides expert advice without farmer asking a question.
- It provides accountable advice. The advice is comprehensive, complete and regular in terms of diagnosis, analysis, advice delivery, follow-up and feedback.
- It follows a proactive approach that will avert many problematic situations.
- It enables quick deployment of services during the times of crises
- It reduces cost and saves time and energy of both farmers and agricultural experts
- It capacitates rural livelihoods and generates rural employment
- It helps in validation of agricultural technology for developing location specific modules.
- It aids in successful implementation of crop insurance scheme by making farm as a unit.
- It is a cost-effective system. It can be made self-sustainable with an affordable service charges.
- It is a scalable system. The complexity increases linearly with the number of farms. It can be incrementally developed to cover all the farms of India without any bottlenecks.
- It can be developed on the available infrastructure as computers and cameras are available. It can be implemented even bandwidth is not available.
- It significantly reduces the lag period between research efforts to practice.
- It shows a great promise in the era of globalization, as it can provide the expert advice that is crucial to the Indian farmer to harvest different kinds of crops based on the demand in the world market with quality and assurance.

6. Implementing Crop-insurance by Piggybacking eSagu

We propose that crop-insurance scheme can be implemented on the top of eSagu without incurring significant additional cost. The system to deliver agro-advice is already under development. We feel that the requirements of crop-insurance can be effectively fulfilled by the resources and processes available from the eSagu system. Here, we explain how several requirements of crop insurance scheme can be met by the resources and processes of eSagu.

6.1 Crop insurance can be implemented on 'individual' basis:

To be successful, crop insurance must be implemented on individual basis. It is absolutely essential to personalize the policies so as to make them meaningful to the individual farm. A farmer should get compensation in the event of crop loss irrespective of his group average. Crop insurance in advanced nations is being implanted on individual basis gaining advantage from large farm sizes (more than 1000 acres). But it is impossible in countries like India where the average farm size is less than one hectare. Surprisingly, in Japan, the unit of insurance is the family operated small farm only. However, implementation of crop insurance on individual basis requires availability of individual farm production histories for a fairly long period of time and also an effective monitoring system that can fix the problem of asymmetric information. eSagu provides advice to each individual farm, however small it may be, in a personalized manner and also records the

production histories which can be used for designing policies on individual basis similar to actual production histories (APH) in USA. The APH in USA is derived from the annual tax returns submitted to the Federal Government by an individual farmer, but in India, farm income is exempted from income tax. More over, tenant farming in India does not permit to maintain production histories of individual farmers where the tenants are changed more often by the land owners. In such cases, individual farm yield histories can be maintained irrespective of the person cultivating an individual farm with the help of Geographic Information System (GIS) and the Global Position System (GPS). Using these systems the boundaries of a particular farm can be represented in terms of longitude and latitude.

6.2 Asymmetric information can be minimized:

eSagu is a proactive system which is typically based on feed back and follow up. As mentioned earlier, adverse selection and moral hazard are the major problems that would arise out of asymmetric information. In adverse selection, farmers are more aware of the risk and those who face the risk with certainty, alone will opt for insurance. In eSagu, the feasibility of producing a successful crop will be assessed based on soil test results, weather history of previous years and endemic pests/diseases associated with locality well in advance of the cropping season. Both the insurer and the insured will be informed in advance if the probability of loosing the crop is almost certain. It also helps the insurer to keep such farms in high risk coverage and charge the premiums accordingly.

Successful crop production necessitates taking intelligent and timely decisions regarding the management of pests, diseases, nutrients and irrigation water right from sowing to harvesting. However, in case of an insured farmer, the interest to take proper care of his crop diminishes more often leading to moral hazard. eSagu delivers advice on regular basis with the help of digital photographs and text information sent by the coordinators. The feed back during the following week gives the compliance by the farmer based on which the next prescription will be delivered to his farm. If the farmer does not comply with the advice, a reminder goes to him immediately. All this information viz. photographs, advices and feed back will be archived and stored in a chronological order (Farm History) in the corresponding farm account. The insurer can access the history at any point of time to know the sequence of developments in that farm over a period of time. So, eSagu will act as a 'watch dog' to hedge the moral hazard.

6.3 Generates quality and reliable data:

India is a diverse country not only culturally but also geographically and climatologically. Like wise, the insurance policies should match the requirements of specific locations based on the soils, climate and natural resources. As mentioned earlier, collection and accumulation of quality and reliable data is the most precious asset of a crop insurance programme. The actuarial soundness of the premium would obviously depend on the accuracy in the field level data. A comprehensive and complete data of an area gives a clear picture of the nature, magnitude and frequency of different perils existed in that locality. As a result, a gradual transition can be effected from generalized multiple-peril insurance to specialized single-peril insurance in due course of time. eSagu has an in-built repository of a comprehensive and complete data on parameters viz. the farmer profiles (personal, family, land, water, soil, credit etc), crop profiles (varieties, recurring pest and disease problems, yields, etc) and weather profile (rainfall, temperature, relative humidity). In India, crop insurance is compulsory to the farmers who avail the seasonal agricultural operations loans from rural credit institutions and a vast majority of the farmers were left out side this frame work whose participation in crop insurance scheme is bare minimum. To achieve large scale participation, the policies should be attractive and meaningful to the farmers addressing the perils that trouble them the most. For such policies, the farmers may not bother to pay higher premium rates if the policy is

personalized with assured compensation in the event of crop loss on individual basis. It all depends on the quality of data generated.

6.4 Reduces administrative costs significantly:
Operational expenses form a significant part in any insurance programme and have a direct bearing on the premium structure. Administrative costs may be a cause of concern particularly in developing nations such as India because of small premiums (farm holdings) in greater numbers. As mentioned earlier, crop insurance requires lot of trained man power and robust infrastructure for constant and continuous monitoring to the address the problem of asymmetric information besides other administrative functions. While, eSagu provides efficient monitoring that effectively hedge adverse selection and moral hazard, its trained man power (coordinators) can be utilized as insurance agents (the commission thus obtained will serve as an extra income for the coordinators in addition to the salary paid by eSagu). The coordinators can perform the basic functions like selling the policies, collecting premiums and providing immediate information to the insurer in the event of crop loss. Where as, the functions that involve direct financial implications such as establishing the premium rates, performing loss assessment and conducting claims adjustments can be carried out by the insurer him self. In a nut shell, the eSagu coordinators and computer center may function as an ad-hoc man power and infrastructure respectively for the insurer at the village level.

6.5 Effective pest prediction cum monitoring system:
Weather parameters like rainfall, temperature and relative humidity have profound influence not only on crop growth but also on pest incidence. Rainfall triggers activity of various insect pests and diseases. Sudden changes in daily temperatures may bring either positive or negative changes in pest populations. Likewise, some air borne diseases will spread like a wild fire under high relative humidity when coupled with favourable temperatures. eSagu collects localized weather information at village level by establishing a simple rain gauge and a low cost digital thermo cum hygrometer which are enough to serve the purpose. This information will be uploaded to the main server on a daily basis so as to make it available to agri-expert team for interpretation while delivering the advices.

6.6 Aids in effective implementation of Rainfall insurance:
Rainfall is the decisive factor particularly in dry farming which triggers the entire faming activity viz. preparatory cultivation, sowing, fertilizer application, weeding etc. The uncertainty in rainfall may adversely affect the prospects of not only the farmers but also the rural folks that are depended directly or indirectly on rainfed cultivation. The rainfall insurance (Varsha Bhima) is being implemented in all the drought prone areas in India offering coverage at various levels. This scheme is typically based on the rainfall data provided by the Indian Meteorological Department (IMD) which covers relatively large number of villages under each of its centers. Moreover, the average amount of rainfall in the past 10-15 years forms the basis for preparing the rainfall index and the liability of an insurance falls with in that amount of rain over the prescribed period. In fact, it is the distribution of rainfall over the critical periods of crop growth that determines the crop yield rather than merely the total amount of rainfall. Because of changing global climate, the spatial distribution of rainfall is also becoming erratic even over a small geographic area. To solve this problem, the low cost weather equipment at eSagu center can be replaced with tamper proof digital weather meters to provide accurate rainfall data for the insurer. These instruments are usually battery operated and record the data in a micro-chip that can be transferred to the computer with help a cable. With this facility, the insurer can monitor not only the amount of rainfall and its distribution but also its actual impact on the crop yield more effectively than ever.

6.7 Promotes technological innovations with strong extension support:

Agriculture is a science which should be dealt with systematic knowledge. It involves taking intelligent and timely decisions for developing sustainable crop production systems. However, Indian farming that was known for its rich traditional knowledge of agriculture is undergoing a paradigm shift through the generations. The educated and intelligent youth in the villages are constantly migrating to urban areas leaving agriculture in the desperate hands of the under privileged. Illiteracy and ignorance makes people risk-averse and rigid towards technological changes locking them with old and often out-dated technologies. Through personalization, eSagu makes even the illiterate farmers to cultivate crops like an agricultural expert by providing them the best extension support in a timely manner. Thus, eSagu helps to promote technological innovations for stabilizing crop yields besides encouraging the smooth flow of institutional credit into the farm sector as the increased probability of crop success also increases the repaying capacity of farm loans by the farmers.

6.8 Commodity futures and options for mitigation of price risk:

Farmers frequently suffer due to unpredictable market fluctuations. These price fluctuations often make the years of high productivity insignificant over the years of low productivity in terms of net returns to the farmers. Several countries including India are backing up its farmers against price risk by announcing the support price. In the recent past, commodity futures and options have emerged as important price risk mitigation mechanisms based on which the price risk related insurance policies are being served in the developed nations. These commodity markets are still at their nascent stage in developing countries for want of sound information and decision support systems at gross roots level. Even though, the volume of business in Indian commodity markets is more than Rs. 3.5 lakh crore annually, the physical delivery of the commodities is bare minimum, an essential precondition for successful transaction. eSagu can play an instrumental role for strengthening the commodity market in India which in due course facilitates to sell insurance policies that will address the price risk. eSagu by virtue of its trained man power and advanced infrastructure can do the following things at village level-

- Bringing awareness and educating the farmers about commodity futures and options.
- Providing technical guidance to ensure that the final produce meet the quality standards as per the pre-harvest agreement for physical delivery.
- The national price movements can be displayed at the village centre on daily basis to gain advantage from the positive price fluctuations.
- Encouraging the farmers to take insurance policies against price risk when once the commodity market is stabilized as a price indicator.

6.9 Brightens the chances of getting reinsurance at international level:

Developing nations have far less access to global crop insurance markets than the developed countries. Reinsurance contracts typically involve high transaction costs related to due-diligence. Reinsurers must understand every aspect of the specific insurance products being insured (for example, underwriting, contract design, ratemaking, and adverse selection and moral hazard controls). Some, minimum volume of business, or the prospect for strong future business, must be present to rationalize incurring these largely fixed transaction costs. The enabling environment to gain confidence in contract enforcement and the institutional regulatory environment are critical to create trust that must be present for a global reinsurer to become involved. These components are largely missing in developing countries (World Bank, 2005). By virtue of several factors explained above eSagu can provide a better control over the crop insurance programme brightening the prospects of getting reinsurance at international level.

7. Conclusions:

Crop insurance is a must for the sustenance of agriculture in any country irrespective of the nature and magnitude of the problems associated with it. Hence it is appropriate to say that "crop insurance is a social obligation rather than a business opportunity". We have discussed how the resources and processes of eSagu system can be utilized to implement the effective crop insurance schemes. eSagu has the potential to address several problems that are plaguing the crop insurance schemes world wide. It can effectively hedge the problems of moral hazard and adverse selection. It can provide quality and reliable data on individual farm basis to design actuarially sound policies that will suit the needs of individual farmers. It can render the best agricultural extension services in tune with the up-to-date technological developments besides providing effective pest prediction cum monitoring system. It increases the probability of crop success which intern improves the repaying capacity of farm loans by the farmers. When the farmer loses crop for the reasons that are beyond his control, he will get the insurance cover thus he would sustain his producing power next season. It also helps the government for effective channeling of disaster relief, covering only the uninsurable perils by bringing all the insurable perils under insurance cover. The administrative costs of the program can also be significantly reduced as eSagu acts as virtual infrastructure and manpower for the implementing agency.

Acknowledgements:

This work is carried out as a part of the project entitled "Building a Cost-effective and Personalized eSagu" which is being developed by IIIT, Hyderabad and Media Lab Asia (2005).

References:

Chandrakanth, M.G., N.S.P. Rebello, 1980. "Crop Insurance for Potatoes: A case study." *Financing Agriculture,* Vol. 4.

Dandekar, V. M., 1976. "Crop insurance in India." *Economic and Political Weekly,* **11** (6): A61-A80.

Freeman, P. K., L. A. Martin, R. Mechler, K. Warner, and P. Hausmann. 2002. "Catastrophes and Development: Integrating Natural Catastrophes into Development Planning." Disaster Risk Management Working Paper Series 4. World Bank, Washington, D.C.

Hazell, P.B.R. 1992. "The Appropriate Role of Agricultural Insurance in Developing Countries." Journal of International Development 4: 567-581.

"http://www.esagu.in" (2006), IT-based Personalized Agricultural Extension System, IIIT, Hyderabad, 2006.

http://www.medialabasia.org (2006), Welcome to Media Lab Asia, 2006.

Jennifer Ifft, 2001. Government Vs Weather: The True Story of Crop Insurance in India. Research Internship Papers 2001, Centre of Civil Society. http://www.ccsindia.org/

Krishna Reddy, P and R. Ankaiah, 2005. "A framework if information technology-based agriculture information dissemination system to improve crop productivity." *Current Science*, 88 (12): 1905-1913.

Krishna Reddy,P, Sudarshan Reddy, A and B.Venkateshwar Rao (2005): eSagu Web-based Agricultural Expert Advice Dissemination System, Final Evaluation Report, IIIT, Hyderabad, April.

Krishna Reddy, P, Syamasundar Reddy, G, and Ratnam, B.V (editors), 2005. Proceedings of National Workshop on IT-based Personalized Agricultural Extension System (IT-PAES2005), 6 May 2005, Hyderabad, India.

Krishna Reddy,P, Sudarshan Reddy,A, Venkateswar Rao,B, and Kumaraswamy,M. 2005. "The Application of ICT in Agriculture--The Case of eSagu model of Web-based Agricultural Expert Advice Dissemination System", Second International Conference on Technology, Knowledge and Society at Hyderabad, India, 12-15 December, 2005.

Krishna Reddy,P, Syamasundar Reddy,G, Sudarshan Reddy,A, and Venkateshwar Rao,B. 2005. "eSagu: An IT-Based Personalized Agricultural Extension System--A Prototype Experience", Seminar on Science, Technology and Development (in the honor of Prof. Amulya K.N. Reddy on the occasion of his 75th birthday) Indian Institute of Science, Bangalore, on 28 October 2005.

Kunreuther, H., R.M. Hogarth, and J. Meszaros. 1993. "Insurer Ambiguity and Market Failure." Journal of Risk and Uncertainty 7: 71-87.

Manoj Kumar K., Sreekumar B. and Ajith Kumar G.S. 2003. Crop Insurance Scheme: A case study of banana farmers in Wayanad district. Kerala Research Programme on Local Level Development. Centre for Development Studies. http://www.krpcds.org/

Ratnam, B.V., Krishna Reddy.P, and Syamasundar Reddy, G,. 2006. "eSagu: An IT based personalized agricultural extension system prototype--analysis of 51 Farmers' case studies", International Journal of Education and Development using ICT (IJEDICT), Vol.2, No.1(March 2006).

Skees, J.R., P.B.R. Hazell, and M. Miranda. 1999. "New Approaches to Public/Private Crop-Yield Insurance." EPTD Discussion paper No. 55, International Food Policy Research Institute, Washington, DC. www.cgiar.org/ifrpi

Stephen Frerichs 1999. Crop Insurance: Some Basics. The Agricultural Law Letter; January-February 1999.

Townsend, R. 2005. "Weather Insurance in Semi-Arid India." Paper prepared for the Commodity Risk Management Group, Agricultural and Rural Development Department, ESW, The World Bank, Washington, DC.

USDA 2005. Final Version of 2005 SRA. Risk Management Agency, USDA. http://www.rma.usda.gov/

World Bank 2001. World Development Report 2000/2001: Attacking Poverty. Washington, DC.

World Bank 2005. "Managing Agricultural Production Risk: Innovations in Developing Countries, Agriculture and Rural Development Department, The World Bank, Washington, DC.